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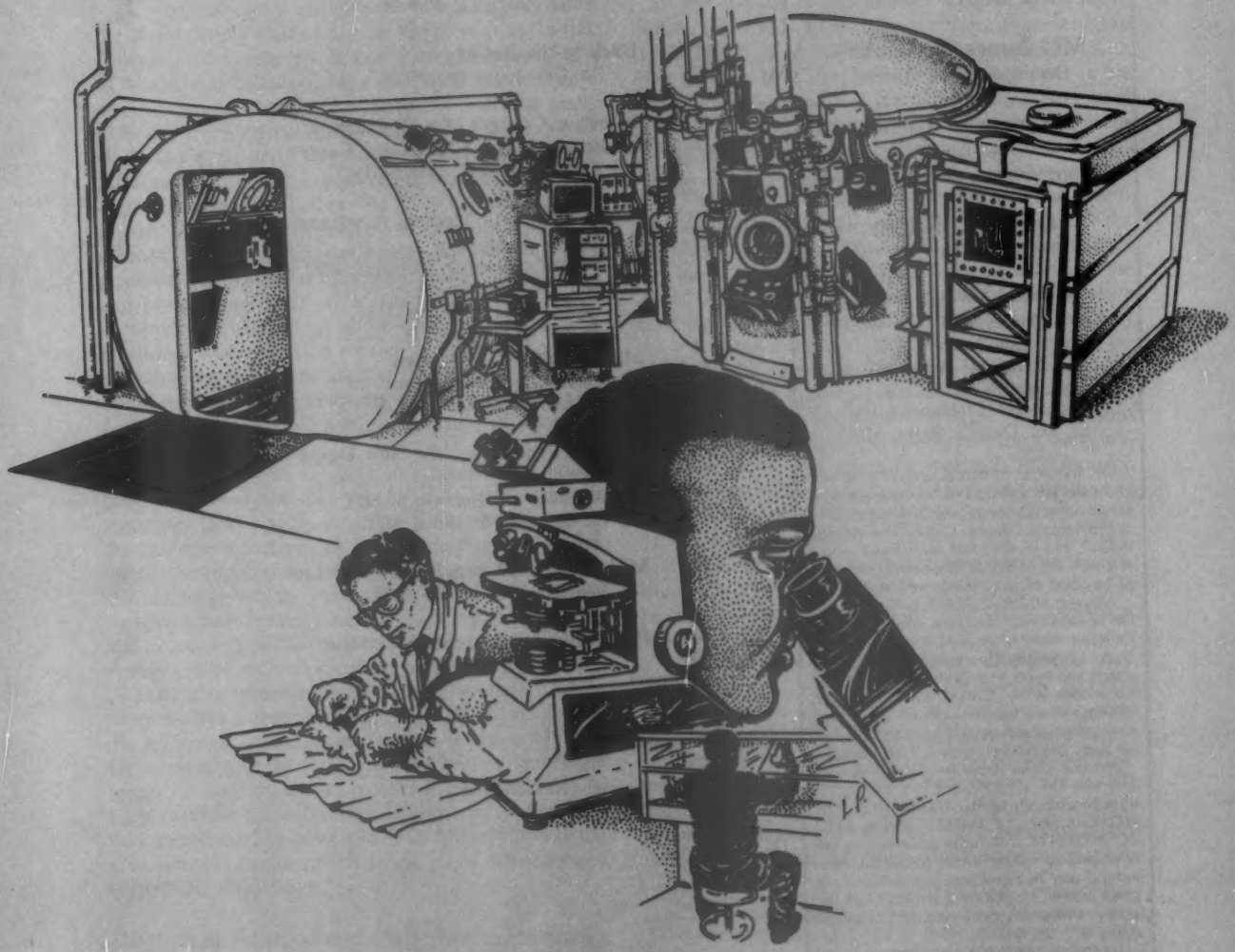

The Armed Forces Institute of Pathology: Exploring Oxygen Physiology (see page 3)

USAF Medical Service Digest

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Oxygen Physiology Research at the Armed Forces Institute of Pathology

MSgt. Ridgely L. Rabold

The Armed Forces Institute of Pathology (AFIP) has a long history as one of this nation's leading pathology institutions. The AFIP began as the Army Medical Museum in 1862, with an initial collection of specimens demonstrating the pathology of wounds and disease encountered in the military environment. Over the years, as the national need grew for a central pathology resource to catalog and study the ever-increasing volume of specimens and information available in pathology, the Institute's role expanded greatly. Today, AFIP is a balanced tri-service and civilian organization that functions as a national and international center for learning and research. Its biological materials, academic resources and professional staff are available to the academic community through its three-fold mission of (1) providing a consultation service for the diagnosis of pathological tissue specimens; (2) providing educational seminars and courses in pathology; and (3) conducting, presenting and publishing results of scientific research.

To continue as a leader in scientific investigations, it is essential that the AFIP develop research strategies in key areas of scientific inquiry pursuing the relevant questions in those disciplines with the latest investigative technology. It was in response to this challenge that the institute chose to form an investigative group to study the basic and applied science and associated pathologies of oxygen and biological systems. The physiological properties of oxygen are of particular importance in military medicine, since oxygen plays a central role in man's ability to adapt to the aerospace environment. Oxygen is also a key factor in promoting the rate of wound healing and tissue repair. It was toward an increased understanding in each of these areas that the Division of Physiology was established in May 1987. In January 1989, the division was renamed the Division of Altitude and Hyperbaric Physiology.

Division of Altitude and Hyperbaric Physiology

The division's mission is to study the effects of oxygen on cells in culture, appropriate animal models* (rodents) and humans at high and low atmospheric pressures. The results of these investigations are to be used to directly support the flight crew in the operational aerospace environment and to provide a basic science foundation for the applications of clinical hyperbaric oxygen therapy.

The division is composed of eight U.S. Air Force personnel selected for their previous experience in research. The three officers (two aerospace physiologists and one laboratory officer) hold doctorates in the biological sciences, and the five enlisted personnel (aerospace physiology technicians) have had previous experience or interest in operational research assignments.

The officers design and conduct original scientific research. Generally, their research studies the effects of oxygen on cells, appropriate animal models and humans by adjusting oxygen tensions through the use of specialized environmental habitats and pressure chambers. These research methods are used to study the effects of oxygen on a variety of biological systems. Areas currently under investigation include wound healing, immune function, oxygen toxicity and altitude hypoxia. The results of these investigations are presented at major scientific meetings and published in recognized scientific journals. Additionally, AFIP-sponsored courses, seminars and lectures in oxygen physiology are prepared for presentation to professional members of the academic community. The division also provides a consultative service to those personnel or agencies requesting information on physiological events related to aviation or hyperbaric physiology.

The division operates a variety of different pressure chambers, each designed for specific research purposes. These chambers range from large man-rated vessels, designed for either high (hyperbaric) or low (hypobaric) pressure exposures, to an assembly of smaller chambers and environment boxes for use with various animal species or cell cultures. The large chambers can accommodate several humans or animal model subjects per exposure plus one or more inside

*The animal models involved in these studies are procured, maintained and used in accordance with Department of Defense regulations, the Animal Welfare Act and the *Guide for the Care and Use of Laboratory Animals* prepared by the Institute of Laboratory Animal Resources - National Research Council. This means that all protocols are approved first by the institute's animal care and use committee, and that adequate veterinary care is provided.

Figure 1. Ensign Daniel Hebert, U.S. Navy, (left) and SrA. Bernard Wilson place a small environmental box containing cell cultures into the glove box.

technicians. The small chambers hold approximately four mice or rats housed in their cages, while the temperature-controlled cell culture chamber can accommodate several culture plates. Additionally, several environment boxes, capable of selecting various types and concentrations of gasses, are used to grow cell cultures when placed inside a standard tissue culture incubator (Figure 1). Generally, any number or combination of these exposure habitats are used in the division's studies and are operated exclusively by division personnel.

A unique aspect of this assignment is the opportunity for the aerospace physiology technicians to work in areas that augment the scope of their normal duty Air Force Specialty Code. It is necessary that technicians operate a variety of sophisticated scientific instruments to acquire research data. Technicians, therefore, routinely work with the high-pressure liquid chromatograph and gas chromatograph, spectrophotometer, luminometer, cell imaging system, blood gas analyzer, automated vascular diagnostic system, and a variety of light and electron microscopic systems. Further, technicians have developed expertise in cell culture methods, small animal model surgery techniques under the supervision of a veterinarian, and the use of oxygen probes for the measurement of oxygen concentration *in vitro* or *in vivo.*[1]

To accomplish its mission, the Division of Altitude and Hyperbaric Physiology is divided into three functional areas: research laboratory, hypobaric (altitude) research laboratory, and a hyperbaric (dive) research laboratory.

Research Laboratory

The division's research laboratory contains a complete cell culture facility capable of supporting various cell lines and primary cultures. The concentration of dissolved oxygen present in these experimental cultures is measured with either a blood/gas analyzer or implantable needle oxygen electrodes. The synthetic and metabolic products from these culture systems are evaluated using a variety of biochemical techniques to identify and measure specific proteins or high-energy compounds.

With respect to small animal models, the division is currently investigating the use of implantable and transcutaneous oxygen electrodes to measure tissue oxygen tensions. Various procedures have been employed to investigate parameters of wound healing, to include a tensilometer to measure the tensile strength of recently healed wounds, and surgical and histological techniques to evaluate cells and tissues participating in the wound-healing process.

The research laboratory is currently engaged in research protocols investigating the effects of (1) chitin and hyperbaric oxygen as promoters of wound healing, (2) oxygen on *in vitro* fibroblast cell proliferation and collagen biosynthesis, and (3) varied oxygen partial pressures on the phagocytic and adherence functions of mouse spleen macrophage cells. Several research protocols are being developed to replace current protocols that are nearing completion. Areas of future investigation include the effects of hyperbaric oxygen on growth factors, angiogenesis,

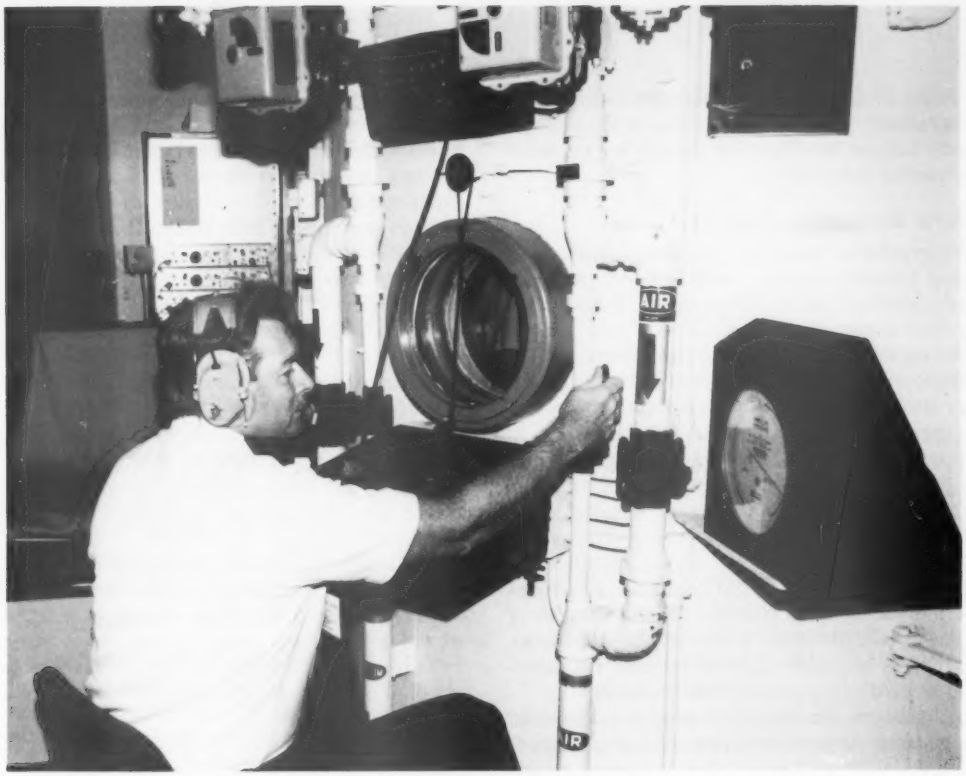

Figure 2. MSgt. Ridgely Rabold operates the hypobaric chamber during a research flight.

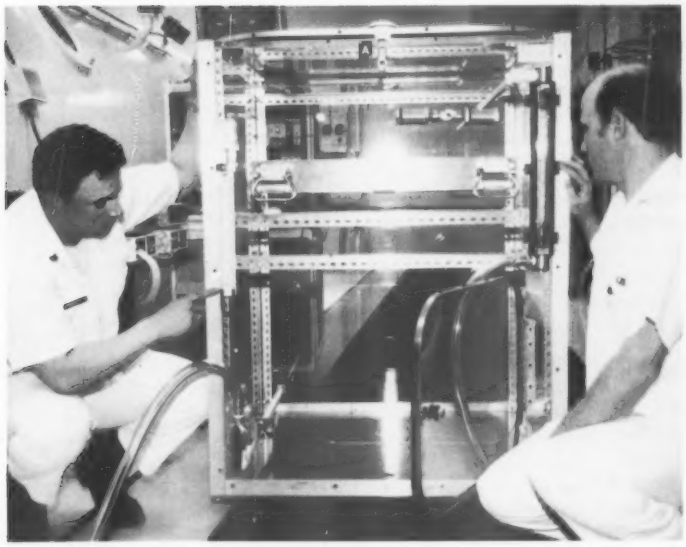

Figure 3. SSgt. Roderick Herring (left) and TSgt. Joseph Casale inspect an animal isolation box before a research dive.

Figure 4. Outside the hyperbaric chamber, SSgt. Roderick Herring scans the monitors that interface with research subjects and equipment inside the chamber.

the viability of the human immunodeficiency virus (HIV) in culture, and the effectiveness of Fluosol and hyperbaric oxygen in adjunctive therapy for the treatment of cardiac infarction.

Hypobaric Research Laboratory

The hypobaric chamber laboratory consists of a man-rated altitude chamber modified with an entry lock and a small-animal model exposure compartment used to investigate the effects of low atmospheric pressures on various physiologic parameters (Figure 2). A Hewlett-Packard ear oximeter, adapted for chamber use, monitors oxygen saturation of hemoglobin, heart rate and frequency of respiration at various pressure altitudes. Several chamber ports permit the penetration of instrument signal wires through the vessel's hull, allowing connection of monitors on the outside of the chamber with their respective probes on the inside for "at altitude" data acquisition. A microprocessor with a desktop computer automates the data monitoring and collection process from these instruments. Additionally, a Minnesota Impedance Cardiograph is available and can be used for determination of cardiac output in human subjects.

The hypobaric chamber laboratory has been used on past research projects involving studies of choice-reaction time, sickle-cell trait at low atmospheric pressures, and the recently completed investigation of mechanisms of hypoxia during simulated air travel in patients with chronic obstructive pulmonary disease (COPD). During this joint project with the Walter Reed Army Medical Center's Pulmonary Medicine Service, several pulmonary research instruments were temporarily added to the hypobaric research facility to enhance data collection in COPD subjects. Possible future areas of research in the hypobaric laboratory include a continuation of the sickle-cell trait study and implementation of a new model to study angiogenesis in small animal models.

Hyperbaric Research Laboratory

The central element of the hyperbaric research laboratory is an 8-foot by 25-foot man-rated, double-lock chamber with an automated operator control console. The 23-ton chamber is supplied by two 580-cubic-foot air accumulators, charged to 290 pounds per square inch (psi) by two oil-free reciprocating air compressors. Design pressure of the vessel is 100 pounds per square inch gauge (psig), 225 feet sea water (fsw), with an operational pressure limit of 73.4 psig (165 fsw). Maximum capacity of the main lock is six ambulatory human research subjects. Two animal model isolation boxes, specially constructed for use at depth, permit investigators to accompany animal models inside the chamber without being exposed to the same breathing environment (Figure 3). Pre-designed penetration plates allow electrical power and instrument signal wires to interface between monitors on the outside of the chamber with their respective probes inside the chamber for "at depth" data acquisition (Figure 4).

The division is using hyperbaric oxygenation protocols to study the effects of oxygen on the physiology of wound healing and tissue repair. Research experiments with human subjects have been initiated to enhance our understanding of the vasoconstrictive effect of hyperoxygenation and its relationship to cutaneous oxygen delivery.

Future studies are planned to investigate oxygen's effects on osteomyelitis, blood loss and organophosphate poisoning.

Summary

The Division of Altitude and Hyperbaric Physiology provides a new dimension to the mission of the AFIP by enhancing its research programs directed toward combat casualty care. It is through this enhanced capability that the institute hopes to encourage collaborative research with the military and civilian academic communities in the fields of aviation and hyperbaric physiology.

MSgt. Ridgely L. Rabold is NCOIC of the Division of Altitude and Hyperbaric Physiology, Armed Forces Institute of Pathology, in Washington, D.C.

Back to the Basics

Lt. Col. Judith Barger, NC

"Do you want to brush your teeth?"

It was a simple offer of help given by a medical service specialist student to a patient confined to bed. But his eagerness to provide what assistance he could to make me, the patient, more comfortable, reminded me just how important — and appreciated — attention to basic nursing care is.

Sometimes it's not until the tables are turned and we find ourselves in the role of patient that we realize how welcome basic nursing care can be. Mouth care is only one example of basic nursing care. Perhaps you can think of others.

The Fundamentals

As a student in a baccalaureate nursing program, I was taught the fundamentals of nursing care that were constantly reinforced as I progressed through the more advanced areas of nursing practice. Viewing health as a state of complete physical, mental and social well-being, my classmates and I focused our attention on seemingly minor details that contribute to complete well-being as we assisted our patients to meet their physical, emotional, spiritual and social needs. Help with cleanliness, grooming and skin care was a daily ritual; tidying up beds and bedside areas was also expected.

When I became an Air Force nurse, I brought the fundamentals of basic nursing care with me to work. My very first task as a new second lieutenant was to give a complete bed bath to a terminally ill oncology patient. I hadn't forgotten the importance of good hygiene — if this was my patient assignment, I wanted to do it well. The patient likely received the most thorough bath of her entire hospitalization. She died later that same day, but I found comfort in knowing that I had helped her to feel clean and more comfortable in those last few hours.

Things We Overlook

Nursing is a helping profession in which we help our patients complete those aspects of care that they are unable, for whatever reason, to complete on their own. Although most of us, if questioned, likely would affirm that we do this, we often think in general terms and overlook aspects of basic nursing care that were once almost automatic. A glance in some patients' rooms might be quite revealing:

- A bedside stand is cluttered and untidy. The situation is compounded when the patient, reaching for an item just out of reach, knocks the item onto the floor.
- A meal tray is placed on an already cluttered over-the-bed table. The patient's position in bed is not conducive to eating.
- Pillows supporting a patient's limb have slipped out of place.
- Blankets intended to provide warmth for a patient are piled haphazardly over the bed. As the patient pulls on a blanket to cover one area of the body, another area becomes exposed.
- An overhead light is left on in a room where a patient is trying to sleep and the light switch is out of the patient's reach. The dimmer bedside light is not working.
- The door to a patient's room is left open and the noise and light from the corridor disturb him while he's trying to rest.
- Nursing personnel do not introduce themselves to a patient. Because name and rank are covered by a sweater, the patient is not sure just who is providing the nursing care.
- No clock is in the room. A patient, who has lost track of time and thinks it is standing still, asks for the time from each person entering the room.
- A patient unable to get out of bed is given a towel and a gown, but no offer to assist with morning care. All toiletries are in the closet across the room.

Most of our patients do not easily give up their habit of caring for themselves. They have been brushing their own teeth, taking their own showers, turning off their lights, closing their doors, tidying up their bedsides, and monitoring their time independently for years. Not all patients will automatically call on us for help in these tasks.

Definition of Good Nursing Care

Good nursing care identifies potential needs and acts on these needs in a timely manner. F. R. Kreuter described the essence of good nursing care when she wrote:

> "Care is expressed in tending to another, being with him, assisting or protecting him, giving heed to his responses, guarding him from danger that might befall him, providing for his needs and wants with compassion as opposed to sufferance

or tolerance; with tenderness and consideration as opposed to a sense of duty; with respect and concern as opposed to indifference." (1)

The shortage of nursing personnel and the focus on high technology have a way of keeping us away from our patients' bedsides. Machines monitor heart rate, blood pressure and brain waves. Machines breathe for the patient, infuse fluids and provide suction. But brushing one's teeth still requires a human hand, even if that hand is holding a mechanical toothbrush. The need for basic nursing care will not fade into obsolescence in the wake of high technology health care. Nor will that need diminish with the decreased number of nursing personnel to provide it. Put yourself in the role of patient, figuratively if not literally, and you'll discover, as I did, just how important and appreciated basic nursing care can be.

Lt. Col. Judith Barger is a clinical nurse at the USAF Medical Center Keesler, Keesler AFB, Miss.

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Effective Control of a Hepatitis A Outbreak In a Child Care Center

Capt. Michael K. Martin, BSC

Hepatitis was first described by Hippocrates. He wrote of "Infectious Icterus." The disease has been with us ever since, and major epidemics have not been uncommon, especially in wartime.

Background

Hepatitis A infections are often asymptomatic, especially in children. Clinical disease, when it occurs, begins as a flu-like illness. The clinical course ranges from one week to two weeks duration of mild illness to a long period of disability. Eventual recovery without complications is the rule. Spread of the infection is by the fecal-oral route with asymptomatically infected individuals playing a key role in the chain of infection. The incubation period ranges from 15 days to 50 days, with an average of 28 days to 30 days. Communicability is from the last half of the incubation period through the first few days after symptoms begin. Asymptomatic infections have communicability periods that are similar to clinical cases.

These characteristics of hepatitis A infections produce outbreaks that behave in a well-defined manner. As with other diseases that are spread from person to person, the number of cases tends to rise gradually over time. The rise is not steady, however, because the incubation period tends to impose a periodicity of approximately four weeks or multiples of four weeks. The resulting epidemiologic curve is a gradually increasing wave-like pattern.

Child care centers are often implicated in outbreaks of hepatitis A because they contain large numbers of susceptible individuals at an age when asymptomatic infections are most common. Spread occurs silently in the child care center. The clinical cases of hepatitis involve the parents and other adult household contacts of children with asymptomatic infections. Unless public health officials are notified and proper investigations conducted, the sources of these adult cases are often overlooked.

In endemic areas, such as many Middle Eastern and Third World countries, a different pattern exists. In these areas, infection in children is very common, so the majority of the population is immune by adulthood, and clinical disease is rare. If susceptible individuals are exposed to this environment, clinical illness is the likely result. Military personnel stationed in endemic areas are at significant risk of hepatitis A. During exercises, and especially in wartime, sanitation tends to deteriorate, increasing the risk even further.

Case Report

In mid-December 1987, the Environmental Health Service at Keesler AFB, Miss., detected an increase in the number of cases of hepatitis A being treated at the USAF Medical Center Keesler. When we investigated these cases, we found that they were traceable to an off-base child care center that had

experienced an outbreak of hepatitis A in September 1987. This center served many Air Force dependents, who comprised more than half of its patrons. By searching laboratory records for calendar year 1987 and interviewing those patients who had positive serologic tests, we were able to demonstrate that the present cluster of cases was really a second wave on the normal cyclical pattern of the earlier outbreak.

In September 1987, prophylactic treatment with immune globulin (IG) had been offered for military dependents who attended the child care center and their household contacts. This treatment had apparently slowed, but failed to stop, the outbreak. Our mission was to determine why these earlier efforts had failed and devise control measures to stop the outbreak.

When the hepatitis testing results for the week ending Dec. 14, 1987, were reported, we saw that the outbreak was continuing to increase. The Environmental Health Service met with the pediatric infectious disease specialist and the immunizations department at Keesler and with Mississippi state public health and regulatory officials. We devised a plan in which the public health department and USAF Medical Center Keesler would simultaneously offer IG prophylaxis to civilian and military personnel, respectively. IG treatment of children and all household contacts would be required before children would be allowed to return to the center. The state child care center licensing authorities agreed to enforce this requirement. The manager of the center provided us with a list of all military dependents who had been in the center during the previous two weeks, the period after exposure in which IG is effective. This list was divided into regular and drop-in groups. We used the list to track the effectiveness of our efforts to get the patients in for treatment.

We met with parents at the child care center to learn about and address their concerns. We briefed the medical center commander, who in turn coordinated with the commander of Keesler Technical Training Center. This degree of coordination was essential to the success of the program and had to be carried out very quickly. The pediatrics department handled the examination and prescription of IG for adult contacts as well as for their children. This saved the families an additional stop at the clinic and thus reduced the total time spent getting them immunized. The Environmental Health Service tracked the time it took to "get through the system" so we could fix any slow spots before too many people were inconvenienced. Some parents expressed a concern about waterborne spread of the disease. Because this is a possible route of spread in unusual cases, the bioenvironmental engineers reviewed water sampling data to rule out a downward trend in water quality. We watched the on-base child care center very closely to be sure the problem was not spreading to it.

Ideally, the involved child care center should have been barred from accepting new children until six weeks after the outbreak was determined to be completely resolved. In this case, we could not expect such strict measures to be imposed. We requested, instead, that the state continue to require IG prophylaxis of any new children and their families before the children were admitted to the center. State officials agreed and implemented strict enforcement procedures. These remained in place for six weeks.

Population immunity is an important concept in situations like this. It is generally accepted that effective immunization of 80 percent of individuals will immunize a population from outbreaks of infectious disease. For some diseases, the percentage needed is even lower. In this case, we immunized 85 percent of the regulars and more than 50 percent of the drop-ins within five days. All children who continued to use the center and their families were immunized. Keesler's immunization department immunized 195 people and the state health department immunized 169 people.

We continued to conduct careful surveillance for the next three months. Any positive serologic tests for hepatitis A were thoroughly investigated. We saw a few more cases the week following the immunization program and one more case two weeks later. To date, no additional cases related to this outbreak have occurred.

Keys to Success

Several factors were key to our success in controlling this outbreak.

- Effective coordination with local and state authorities allowed treatment of the entire child care center population rather than just the military dependents.
- Patient concerns were aggressively pursued, ensuring patient cooperation.
- State regulatory agencies carefully measured their activities to ensure continued voluntary cooperation of the child care center management.
- Health care providers throughout the military and public health systems were conscious of the special nature of this operation. They made the extra effort needed to remain helpful and friendly in spite of the understandable, but irrational, combativeness of many of the parents. Without this extra effort, compliance easily could have dropped to a level that would not have produced effective population immunity.

Lessons Learned

When, as environmental health professionals, we set out to deal with an outbreak, we must understand

the epidemiology of the disease or condition with which we are dealing. We must accurately define the population at risk and, finally, we must enlist the cooperation of all necessary elements of the health care system to implement effective controls. Achieving these goals, which seem very simple in retrospect, can become complicated in the heat of an outbreak. Taking time during the investigation to critically review these goals will help us to avoid making some tempting but dangerous assumptions that could threaten the interdiction of the disease process.

Several factors make hepatitis one of the classical models for the study of communicable disease epidemiology. The epidemiology of hepatitis A has been well-worked-out, and the control measures needed are described in many references. Because hepatitis A is endemic in many militarily important parts of the world, a thorough knowledge of its epidemiology is essential in our role as medical intelligence officers. In peacetime, it will not be unusual to have to deal with a child care center outbreak. By close examination of our performance in dealing with relatively routine cases, such as this one, we can greatly improve our readiness to carry out our wartime and disaster epidemiology mission.

Capt. Michael K. Martin is the deputy chief of the Environmental Health Service at the USAF Medical Center Keesler, Keesler AFB, Miss.

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WAR-MED and Medical Readiness Systems Analysis

Lt. Col. Marvin D. Meinders, BSC
Maj. Garry W. Stanberry, MSC
Capt. Jimmie D. Smith, MSC

In June 1986, the Air Force surgeon general initiated the Wartime Medical (WAR-MED) Work Center Description (WCD) project, which has now evolved into the Medical Readiness Systems Analysis, or "MRS A." The goal of the WAR-MED WCD project was to identify tasks that Medical Service personnel would perform at each of the Air Force's wartime four-echelon health care systems. These tasks would be used to validate and justify resources for wartime health care delivery.

Organization

The organization of the project included a WAR-MED steering committee, subgroups, group facilitators and an administrative support staff. The WAR-MED steering committee was composed of representatives from each theater and the Headquarters, U.S. Air Force, surgeon general's office directorate level. More than 350 senior officers and noncommissioned officers were divided into 64 subgroups, each consisting of four to six experienced specialists and, in most cases, the respective Air Force surgeon general's consultant. Facilitators and administrative support were provided by the Medical Wartime Hospital Integration Office (MWHIO) of the surgeon general's Medical Readiness Division (HQ USAF/SGHR).

Process

The process of the WAR-MED WCD project involved the following steps :

1. The steering committee provided subgroups with all available background data, e.g., theater concepts of operations, theater assumptions and current policies from other DOD efforts such as Deployable Medical Systems (DEPMEDS).

2. The subgroups developed operational and resource support assumptions and submitted them to the steering committee for review.

3. These revised assumptions were returned to the subgroups for their consideration.

4. Upon consensus within the subgroups, tasks were developed, logically sequenced by events and depicted in functional flow diagrams for each

echelon. These diagrams form the basis for computer modeling of our wartime capabilities and patient flows under a recently awarded contract.

5. The final effort was documenting resource requirements to perform each task, e.g., manpower, equipment, training, base support, etc. (Figure 1).

Data Base

The WAR-MED WCD project yielded a 20-megabyte WAR-MED data base that identifies 5,771 tasks to be performed by 67 wartime medical functional account codes.

Other areas of the WAR-MED data base include the macro-level "assumptions," the concepts of operation for each subgroup and the work center descriptions. The WAR-MED project generated more than 1,200 assumptions, for example, "There will be no radiology capability at the second echelon of care," or "A tour of duty will normally consist of 12-hour duty shifts." This 120-page document of assumptions was staffed through the surgeon general's office and the surgeons offices of the major commands. The approved assumptions were then distributed to all the major command surgeons for use in their wartime planning. The assumptions will be incorporated into Air Force Regulation 160-25, "Medical Readiness Planning and Training," as policy guidance. Staffing of both the concepts of operation and the work center descriptions is well underway.

Future Plans

Now that we have completed the data collection phase and staffing of the WAR-MED data base, the question is, "Where do we go from here?" Our foremost effort is to continue working the Air Force Medical Management Engineering Team (AFMEDMET) to develop wartime medical manpower standards. We are also using the WAR-MED data base to refine our requirements and programs for training, patient information and administration, and materiel/logistics support. The WAR-MED data base is just one portion of

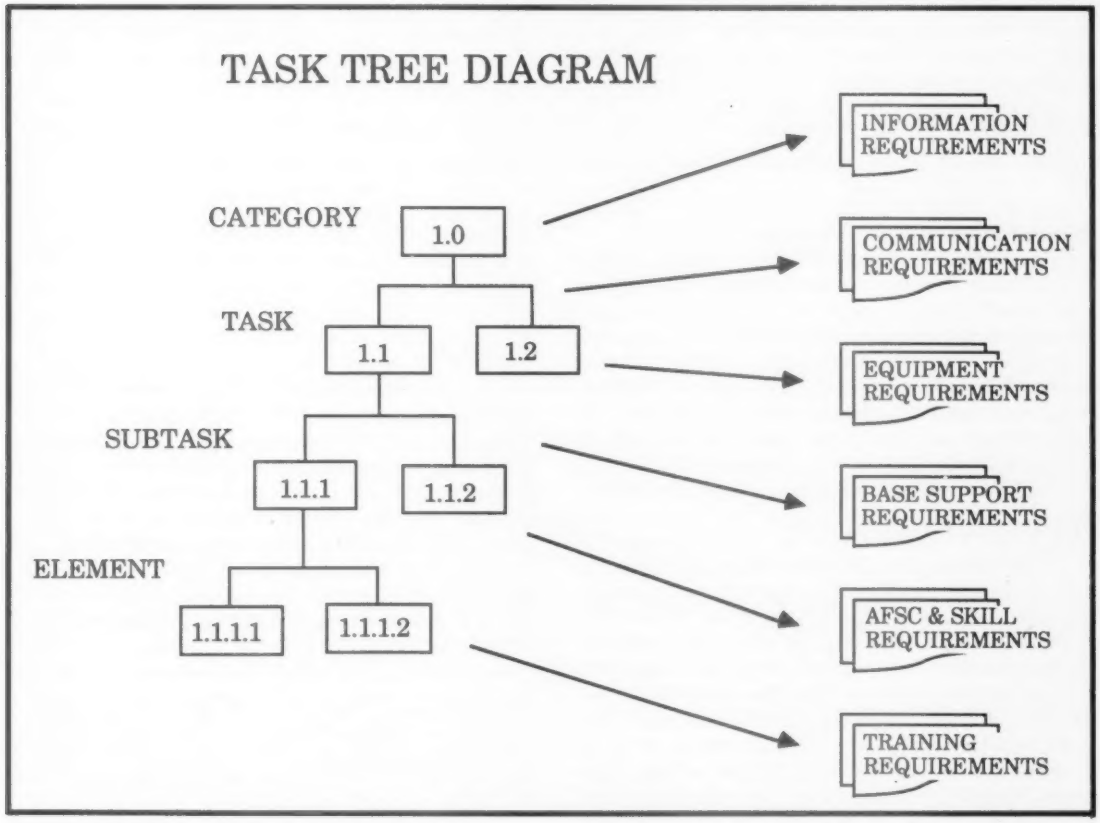

Figure 1. In the Wartime Medical Work Center Description (WAR-MED WCD) project, tasks are developed and sequenced by events in functional flow diagrams, and resource requirements to perform each task are documented.

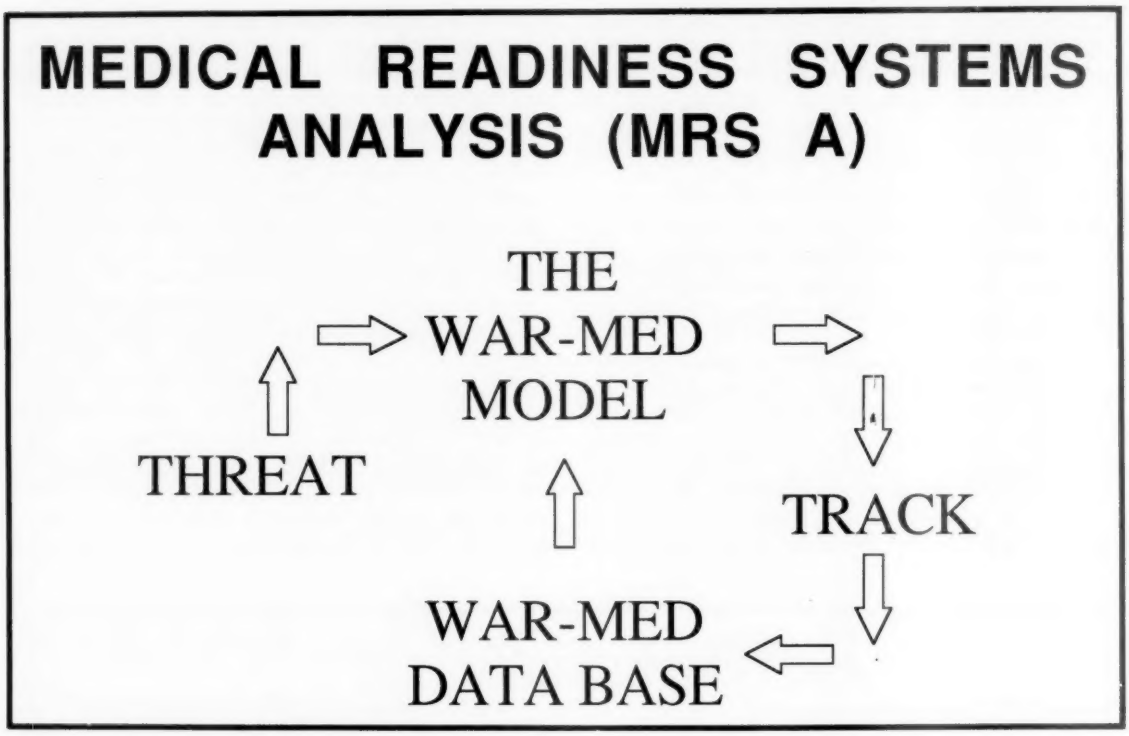

Figure 2. The Medical Readiness Systems Analysis — MRS A — has four parts, as depicted here.

the overall four-part MRS A program (Figure 2).

The WAR-MED model is a "capability" model that is being developed from the WAR-MED data base. It will be used to analyze wartime medical procedures and patient flows. Medical planners can use it to analyze "what if" situations to identify strengths and weaknesses of their local or regional wartime health care delivery system. However, we will be unable to best use this system until we have accurate estimates of our casualty numbers and our casualty mix. This is the function of the "THREAT" model.

THREAT and TRACK

THREAT is an acronym for Threat Related Attrition. Currently, the Air Force medical and personnel communities are working jointly to identify these casualty numbers and the casualty mix. The Air Force Medical Service needs to know the quantity and types of injuries, and the personnel staff needs to know how many replacements they must provide in a war. This model will reflect requisite planning factors for conventional and/or chemical warfare battle injuries, with future capabilities to include disease non-battle injuries. The contractual effort began in September 1987.

No system is complete without a means to evaluate its effectiveness. Threat Related Attrition and Casualty Kit (TRACK) is an exercise kit designed to conduct and evaluate exercises and provide feedback into the WAR-MED data base. The updated data base will, in turn, drive changes to the WAR-MED model.

Conclusion

In summary, the WAR-MED program is the central core to the Medical Readiness Systems Analysis, MRS A, which is designed to assist Medical Service planners for many years to come. It represents the first comprehensive Air Force effort to apply an auditable systems analysis approach to the Air Force four-echelon health care system. When completed, we will have an integrated, dynamic medical readiness program that will provide us with the planning tools to identify and validate the resource requirements we will need to meet our wartime mission.

Lt. Col. Marvin D. Meinders and Maj. Garry W. Stanberry are medical readiness managers at the Medical Wartime Hospital Integration Office (MWHIO), Medical Readiness Division, Office of the Surgeon General, in Fort Detrick, Md. Capt. Jimmie D. Smith, also a medical readiness manager at the MWHIO when this article was written, is now a medical plans officer at the Office of the Surgeon, U.S. Southern Command, Quarry Heights, Panama.

Minor Burn Management

Capt. Jeffrey A. Niezgoda, MC
Lt. Col. James L. Keller, BSC

The military medical community has not been immune to recent cost-cutting measures and budgetary restrictions. We have been challenged with maintaining our usual high standard of medical care with fewer personnel and less material, equipment and support. At David Grant USAF Medical Center, Travis AFB, Calif., we have found a successful method for continuing to provide high quality medical care despite the current economic environment. The Department of Emergency Medicine, in cooperation with the Department of Physical Therapy, has established a burn clinic for treatment of outpatient burns. This interdepartmental teamwork has improved patient care while maximizing use of our precious resources.

Introduction

It is estimated that 2 million Americans suffer a thermal injury each year. Approximately 95 percent of these injuries are treated as outpatients (1). Outpatient management is appropriate for minor burns not involving the feet, hands, face or genitalia. Minor burns are partial skin thickness thermal injuries to less than 15 percent of the body surface area in adults, 10 percent in children. Visits to our emergency room for care of thermal injuries are common. The percentage of these patients who we treat on an outpatient basis agrees favorably with the national statistics.

Every patient visit to the emergency room places a demand on manpower and resources as each patient is triaged by a nurse, evaluated by a physician and cared for by the entire staff. However, patients with thermal injuries are unique in that they also require daily follow-up for debridement and dressing changes. A burn patient usually requires several visits, quickly consuming a significant amount of health care provider time and emergency medical resources.

Since follow-up visits for burn patients are triaged as non-urgent, this patient is often required to wait for extended periods of time while emergent and urgent patients are cared for. The frustration of a prolonged waiting time markedly decreases the patient's compliance with daily visits for dressing changes, and thus the patient is at increased risk for infection and poor wound healing.

The Burn Clinic Concept

To improve patient compliance with the prescribed burn therapy regimen and to attempt to better direct the use of hospital resources, a burn clinic was established in our physical therapy department. In the first year of operation, this clinic cared for 34 patients. Each patient averaged nine follow-up visits to the clinic, for a total of 306 patient interactions. This number is nearly the equal to the volume of patients seen in our emergency room in one week, theoretically enabling the emergency staff to provide seven additional days of medical care.

In addition to these benefits, patient satisfaction is obvious, as follow-up compliance is nearly 100 percent. From a medical standpoint, the quality of care has also improved. Infection rates for outpatient burns are generally 5 percent (2), but none of the patients treated in our burn clinic developed infection.

Following the initial evaluation and care in the emergency room, the patient is given a "burn sheet." This sheet of instructions provides the patient with additional information concerning burns and directs the patient to the burn clinic for follow-up care. The hours of the clinic are stressed to minimize the disruption caused by unscheduled visits to the physical therapy department. The clinic operates seven days per week and rarely requires more than one hour per day.

A physical therapist runs the clinic, providing optimal wound debridement via whirlpool and skilled dressing reapplication. Each member of the physical therapy staff is trained in burn care and clinic operating procedures. The Air Force gains additional benefit in having physical therapists and technicians trained in burn management, as burn and wound care is the wartime task of this group of medical specialists.

Clinic Operating Procedures

Upon presentation to the burn clinic, the patient is registered as a physical therapy department patient and triaged to the hydrocenter, where a second assessment is made by a physical therapist trained in burn and wound care. A treatment plan is then outlined based on this assessment. Factors such as etiology of the burn and size and depth of tissue destruction are considered and influence the formation of the treatment plan.

Once the treatment plan is formalized, the burn is

irrigated with sterile water. Necrotic tissue debridement is next accomplished with iris scissors and forceps. Special attention is paid to intact blisters to avoid rupturing them during this process. The wound is then submerged in a whirlpool bath maintained at 96 degrees Fahrenheit. Chlorazene is added to the whirlpool to control nosocomial infections (3). A 15- to 20-minute hydrotherapy session assists in further passive debridement and wound cleansing. At the completion of the hydrotherapy treatment, the wound is dried with a sterile towel. Maintaining sterile technique, Silvadene is applied to the burn and the area is dressed with gauze pads and a Kerlix wrap.

Daily sessions of hydrotherapy, debridement and wound care are continued for five to ten days. The physician on duty in the emergency room is available to reevaluate a burn clinic patient should problems or questions arise concerning wound healing. Once a bed of granulation tissue has formed, the wound is covered with Tegaderm. This dressing is then inspected every three to five days and reapplied as necessary. Complete epithelialization is the endpoint for wound care. Before being discharged from the burn clinic, the patient is instructed to massage the burn daily with bacitracin or cocoa butter to keep the scar tissue soft and pliable.

Conclusion

The burn clinic and the physical therapy department have proven their value in the management of thermal injuries, increasing patient satisfaction and improving wound care. Our cooperative approach to outpatient treatment of burn injuries has been beneficial for David Grant Medical Center and for the Air Force. We recommend interdepartmental teamwork whenever possible for maintaining high health care standards and maximizing the use of medical manpower and resources.

Capt. (Dr.) Jeffrey A. Niezgoda is a staff physician with the Department of Emergency Medicine, David Grant USAF Medical Center, Travis AFB, Calif. Lt. Col. James L. Keller is chairman of the Department of Physical Therapy at David Grant.

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A Team Success — The New David Grant

Capt. John R. Baldwin II , MSC
Lt. Col. John E. Holes, MSC

Imagine the awesome task of planning, designing and then constructing a 300-bed medical center. Further imagine that while other Military Construction Program (MCP) projects have varying degrees of user involvement, the hospital senior staff is unfamiliar with the guidelines, procedural manuals or regulations on how this feat is accomplished. Certainly a facility's executive committee is aware that space, functional and engineering criteria are established and must be adhered to, but each MCP project is unique. Fortunately, the Health Facilities Division, Office of the Air Force Surgeon General, has been chartered to handle this type of situation.

This paper focuses on the experience of the David Grant USAF Medical Center, Travis AFB, Calif., Replacement Project and one approach employed by the Health Facilities Division and the David Grant staff (the user) that proved to be highly successful. It should be noted that while many players and organizations deserve recognition, this article addresses the relationship between the two medical partners of the overall team: the health facilities officers and the medical center's Development Directorate assigned to the Travis replacement project.

Background

The David Grant success story begins in the late 1970s following several unsuccessful attempts to program a medical MCP project to replace the existing inadequate medical structures. This new effort was the seventh attempt to program a project over the past 13 years. Although skepticism existed, by early 1981 the Health Facilities Division and the Health Facilities Office-Western Region worked closely with the Air Force medical consultants, the Military Airlift Command surgeon's staff, and the staff at David Grant in developing the planning documents that defined the space requirements for the proposed medical center project. During this effort, more than 100 chairpersons, chiefs, superintendents, NCOICs and other personnel from the medical center worked with a half dozen health facilities officers and nearly 30 Air Staff and major command (MAJCOM) medical consultants to produce the Program for Design (space plan), Design Narrative (tells the architect how the spaces interrelate), and the Medical Equipment List. These early planning efforts were the solid foundation upon which the design and later facility construction were based.

The result of this planning effort determined a facility requirement of 807,000 square feet, $234 million, with 298 inpatient beds, 75 aeromedical staging flight (air evac) beds, and 52 dental treatment rooms. The facility also had more than 3,500 rooms, miles of corridors, nearly 2,000 parking spaces, and thousands of pieces of medical equipment. The equipment list alone was more than 600 pages! The sheer numbers were enough to raise serious questions as to how to manage a project of this magnitude.

Team Building

A key to the success of this endeavor was the Air Force Medical Service senior management commitment of resources to this project in the early stages. They agreed that past ways of managing medical MCP projects must be improved to ensure user satisfaction. Traditionally, a project may have different health facilities officers (HFO) during the various phases of planning, design and construction. This is because of the extremely long time line (at least 10 years) that a project usually follows. This same situation occurs with the medical user, that is, staff rotation does not permit continuity through the duration of the project. Also, a medical facility's development directorate (the local user transition team) had never been established before design completion. Therefore, a way was sought to maintain the well-coordinated efforts achieved during the planning phase.

In April 1981, the Health Facilities Division dedicated a full-time HFO solely to the David Grant project, with backup assistance available from the other HFOs in the division. Usually, an HFO has several bases of responsibility, and thus, several projects, but because of the size of David Grant, a full-time project officer was assigned. This officer would be the focal point for medical functional input from the user to the other design and construction team members. Additionally, the division committed to leaving that officer on the project during construction if funding remained on track for fiscal year 1985.

In concert with the Health Facilities Division, the Military Airlift Command surgeon and the David

Grant commander agreed to establish the David Grant Development Directorate early. In the past, a development directorate was established only during construction and primarily focused on furniture and equipment purchases, move-in requirements, staff transition training, and the processing of user changes identified by the professional staff. Consequently, they were not familiar with the planning and design intent of the facility and spent much of their time trying to catch up. While the David Grant Development Directorate was not officially sanctioned until October 1983 (almost two years before construction started in June 1985), two of its current nine members participated in every planning and design review since 1981. The remaining members also participated in the latter stages of design review. Again, the early commitment of the MAJCOM surgeon and medical treatment facility commander to the success of the project was reflected in their retention of qualified, experienced people from the planning phase through the occupancy phase. History had shown that the reassignment of a key player could lead to costly medical user change orders during construction, because the design or planning intent was lost with the departed individual.

Team Work

Once the primary players were identified, a common philosophy surfaced — work for the success of the project, work as a team, and above all, produce a quality project that meets the needs of the users. A positive, can-do attitude started that would eventually persist throughout design and construction.

User involvement was strongly encouraged. Along with the Development Directorate, from 70 to 100 David Grant personnel participated in five major reviews during the conceptual phases of design, including the medical equipment placement drawings. Many of these same reviewers had participated in the planning phase. All of the reviewers' comments and opinions were reviewed and consolidated by the HFO with assistance from the Development Directorate to ensure planning intent was maintained in design. For the most part, this involvement was of the "bottom-up" variety versus the "top-down." For instance, if the medical library was under review, it would be the medical librarian involved in reviewing the design. Department chairpersons would later be shown the results of their subordinates' efforts. Conflicting opinions would then be addressed in a non-confrontational mode.

After the equipment placement drawings were completed, the design was locked in and future functional changes were discouraged. However, the team work did not end there. The remaining three major review efforts of the construction documents (floor plans and specifications) were participated in by not only the HFOs as in the past, but by the Development Directorate staff as well. Once again, the sheer magnitude of the effort — more than 1,700 floor plans and more than 3,600 pages of specifications — warranted a monumental effort. During these reviews, the Development Directorate assisted the HFOs by performing key review responsibilities. This combined effort, according to the Naval Facilities Engineering Command's authority on plan checking, saved the government between $5 million and $10 million by identifying problems and errors that, if undetected, could have resulted in costly change orders once construction began.

After the design was completed, the medical teams' participation increased. The HFO moved to Travis, along with two other HFOs, and they became the on-site project HFOs (PHFO). Additionally, the

The new David Grant USAF Medical Center at Travis AFB, Calif., has and 52 dental treatment rooms.

807,000 square feet, 298 inpatient beds, 75 aeromedical staging flight beds

The 95 percent design review of the David Grant USAF Medical Center replacement project involved 65 participants at the architect's office and saved the government $3 million to $5 million in potential change order costs.

Development Directorate was now at full manning. The stage was set for the most challenging phase of an MCP project — construction.

Customarily, the PHFO now had the task of assuring that all 56 areas of the facility were built in accordance with the user's directions established during planning and design. As with planning and design, construction was too large to manage in traditional ways. Therefore, in addition to their normal duties, all members of the Development Directorate participated in varying degrees in the PHFO quality assurance inspection program for medical functional areas. Each member of the team was assigned an area or areas of the facility. As each stage of an area was completed, the assigned team member would inspect it from a

functional viewpoint. For instance, if a cabinet was to be hung at a certain elevation in a room, the team member assigned to that area would insure the proper structural backing support was included. The assistance of the Development Directorate in the quality assurance inspections helped provide time for the PHFO to review the more than 1,500 contractor submittals on equipment and materials, as well as answer many of the 6,600 contractor "Requests for Information" to clarify various design questions.

On top of this, the team had to make certain that subjective and costly changes were not directed by new members of the professional staff who were unfamiliar with the concept and intent of the design. This is where the foresight of the senior management paid off. By assigning the corporate memory of planning and design to the construction team, only valid changes occurred.

The Measure of Success

A quality product, on time, and under budget — these three items are the recipe for success in any normal Military Construction Program project. Unfortunately, the key ingredient is often omitted. That ingredient is a satisfied user.

How can user satisfaction be measured? One way is the number of change orders generated by the users to alter the original design. To date, with project construction substantially completed (only minor items remain) and the building open for patient care, there were only 19 medical user changes valued at a negative $16 thousand. This is truly remarkable when compared to much smaller projects that were not similarly managed but had many dozens of medical user changes costing hundreds of thousands of dollars. Further, this user satisfaction is also an indicator of the quality of the product. If the quality were poor, more user changes could be anticipated.

Another measure is being on time. Over the seven-year history of the David Grant Replacement Project, not one single milestone has been missed — an incredible record by any standard, but particularly noteworthy on a project as large and complex as this one.

Finally, the last measure of success — under budget. This project was originally estimated to cost $234 million. Direction was received to reduce this amount by $30 million at the 35 percent design stage. Today, the project is nearly $10 million below its authorization for $206.2 million. Only a strong management team effort could accomplish this feat.

Lessons Learned

Some key lessons were learned from the David Grant USAF Medical Center Replacement Project that may serve as a guide to senior management. They are:

1. Commit quality personnel resources early.
2. Develop common goals and objectives and then jointly strive to achieve them.
3. Retain key players (HFO, Development Directorate, Engineering, etc.) on a large project (medical center, regional hospital or large base level hospital) to allow continuity during each phase of planning, design, construction and transition.
4. Incorporate the staff (users) who will actually operate the facility into the planning and design process.
5. Develop clear channels of communication and then keep those channels open.
6. Simplify coordination efforts to the greatest extent possible. Don't overlook anyone but ensure each individual is cognizant of everyone else in the coordination process.
7. Encourage professionalism from all players.
8. Document actions and decisions made and ensure ease of retrieval (computerized) for future use.
9. Plan, design and build for the ultimate user — the patient.

By applying these lessons learned from the David Grant project, future projects stand a greater opportunity of bonding the two key medical partners into a true team effort. In turn, these partners bring credibility and trust to the construction project, which enhances their relationship with the engineering members of the construction team.

Capt. John R. Baldwin II is the deputy chief, Health Facilities Programs Branch, Health Facilities Division, Office of the Surgeon General, at Bolling AFB, DC. Lt. Col. John E. Holes is the associate administrator, Logistics and Planning, and director of Development at David Grant USAF Medical Center, Travis AFB, Calif.

Military Health Benefits and the Law

Maj. Ralph B. Charlip, MSC

This article attempts to provide some insight into the effect of the law on military health benefits. The challenge is how to work effectively and use the Air Force health care system given the constraints the Air Force Medical Service is experiencing. With the limitations on money, equipment, supplies, and TDY, how and what can be done within the limits of the law to stretch our resources?

What the Law Says About Military Health Care Entitlements

Military health care entitlements are normally specified in Title 10 of the United States Code (U.S.C.; commonly called Title 10), Chapter 55. While Title 10 specifies certain benefits, there are also specific prohibitions as to what health care can be provided for dependents of either active duty or retired members. An example is the prohibition against custodial and domiciliary care.

Active duty entitlements are outlined in 10 U.S.C., section 1074a. Health care for retirees is provided on a space-available basis under section 1074. Sections 1076 and 1076a provide space-available care to dependents, while section 1077 lists exclusions for dependents. By reading these sections in the law, we determine the priorities for care: active duty, first; dependents of active duty, second; and retirees and their families, third.

Since a large portion of health care is provided to non-active duty people on a space-available basis, it's important to know how to define space availability. Section 1076(c) of Title 10 says that the determination as to what is available is solely up to the medical facility commander but does not define the term, "space available." So, space availability is really at the commander's discretion. Air Force regulations and various policies try to help the commander define availability, but the bottom line is, it's up to the commander's interpretation.

One other limitation in the law is included in section 1076(d). This section requires the secretaries of the services to prescribe regulations that do not prevent access for dependents based on the sponsor's branch of service. A parallel requirement preventing discrimination based on branch of service is included in sections 1076(a) for active duty members and 1074(b) for retired members.

The Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) is an entitlement specified in section 1079 for active duty dependents and section 1086 for retired members and their dependents.

In summary, the law states that:

- Budget or resource constraints are not justification for eliminating active duty entitlements; however, these constraints can be used as justification for limiting space-available care to other authorized beneficiaries.
- The local medical treatment facility (MTF) commander has the final authority on availability of services and capability.
- Health care services must be provided equally to each beneficiary category without regard to service affiliation.

Making the Law Work For the MTF Commander

While the law gives the MTF commander the ultimate authority to determine availability of care, commanders need to keep in mind the Air Force Medical Service mission, goals and values. These are summed up in the mission statement:

> "The Air Force Medical Service mission is to ensure maximum wartime readiness by developing and operating a comprehensive community-based health care system that maintains the health and morale of Air Force members by providing or arranging timely quality medical service for all active duty members, their families and other beneficiaries. During contingencies, this health care system must rapidly expand, mobilize and deploy to provide medical support for Air Force operations worldwide."

If the MTF cannot provide care through the direct care system, we would expect it to *arrange* for alternative care through the Health Care Finder program, external Partnership agreements and CHAMPUS.

When local resources become, or are forecasted to become, so constrained that there is no option but to cut existing services, advance coordination and staffing with the major command, the Office of the Surgeon General (HQ USAF/SG) and other Department of Defense medical facilities in the local area are essential. In fact, Department of Defense Instruction 6015.20, "Changes in Services Provided at Military Medical treatment Facilities (MTFs)," and Air Force Regulation 168-4, "Administration of Medical Activities," require that certain information on closure or the limiting of services must be reported to the major command, HQ USAF and the Office of the

Extracts from 10 U.S.C.

Section 1074, "Medical and dental care for members and certain former members:

(a) ... a member who is on active duty is entitled to medical and dental care in any facility of any uniformed service.

(b) ... a member or former member of a uniformed service who is entitled to retired or retainer pay, or equivalent pay, may upon request be given medical and dental care in any facility of any uniformed service, subject to the availability of space and facilities and the capabilities of the medical and dental staff."

Section 1076, "Medical and dental care for dependents, general rule:

(a)(1) A dependent (referring to active duty dependents) ... is entitled, upon request, to the medical and dental care described by section 1077 of this title in facilities of the uniformed services, subject to the availability of space and facilities and the capabilities of the medical and dental staff.

(b) ... a dependent of a member or former member (referring to an individual who is retired) may, upon request, be given the medical and dental care prescribed by section 1077 of this title in facilities of the uniformed services, subject to the availability of space and facilities and the capabilities of the medical and dental staff ....

(c) A determination by the medical or dental officer in charge or the contract surgeon in charge, or his designee, as to the availability of space and facilities and the capabilities of the medical and dental staff is conclusive. Care under this section may not be permitted to interfere with the primary mission of those facilities.

(d) ... dependents entitled to medical or dental care under this section will not be denied equal opportunity for care because the facility concerned is that of a uniformed service other than that of the member."

Section 1077, "Medical care for dependents: authorized care in facilities of uniformed services:

(a) Only the following types of health care may be provided under section 1076 (dependents) of this title:

(1) Hospitalization.

(2) Outpatient care.

(3) Drugs.

(4) Treatment of medical and surgical conditions.

(5) Treatment of nervous, mental, and chronic conditions.

(6) Treatment of contagious diseases.

(7) Physical examinations, including eye examinations, and immunizations.

(8) Maternity and infant care.

(9) Diagnostic tests and services, including laboratory and X-ray examinations.

(10) Dental care.

(11) Ambulance service and home calls when medically necessary.

(12) Durable equipment, such as wheelchairs, iron lungs, and hospital beds may be provided on a loan basis.

(b) The following types of health care may not be provided under section 1076 of this title:

(1) Domiciliary or custodial care.

(2) Prosthetic devices, hearing aids, orthopedic footwear, and spectacles except that -

(A) outside the United States and at stations inside the United States where adequate civilian facilities are unavailable, such items may be sold to dependents at cost to the United States, and

(B) artificial limbs and artificial eyes may be provided.

(3) The elective correction of minor dermatological blemishes and marks or minor anatomical anomalies.

(c) A dependent participating under a dental plan established under section 1076a (the DDP) of this title may not be provided dental care under section 1076(a) of this title except for emergency dental care and care that is not covered by such plan."

The CHAMPUS program is an entitlement specified in section 1079 for active duty dependents and section 1086 for retired members and their dependents. As such, CHAMPUS-based care cannot be cut back.

Assistant Secretary of Defense for Health Affairs (OASD-HA). One purpose of the advance coordination is to allow the major command and HQ USAF/SG the opportunity to minimize the curtailment of services by providing additional resources.

Since beneficiaries are free to use CHAMPUS (except for the requirement to obtain nonavailability statements for inpatient care in certain cases), CHAMPUS costs cannot be easily contained. As you know, there are several programs and demonstration projects underway attempting to better control CHAMPUS funds. Beginning in fiscal year 1988, CHAMPUS funding came under the direct control of the services. This means that when health care is shifted from the direct care system to CHAMPUS, these costs must be paid by the respective uniformed service. The Air Force projects a $100 million CHAMPUS shortfall for fiscal year 1989. While local MTFs do not have direct control over these funds, they are impacted directly when they shift care from their MTF to CHAMPUS (such as by not filling prescriptions from civilian providers). This happens because the Air Force must reprogram funds to cover CHAMPUS, taking funds away from other Air Force programs. This action also constrains direct care funds, limiting the MTF's ability to upgrade the facility, purchase needed equipment and supplies or provide TDY funds to ensure the quality of health care providers is maintained. In short, the commander is the ultimate custodian of medical — direct care and CHAMPUS — dollars.

Summary

The law is the basis for military health benefits — it establishes the priorities for care, limits benefits, requires equal access without regard to the sponsor's branch of service, and gives the local MTF commander discretion in determining space availability.

Regulations require that some changes in existing services be reported to higher headquarters. Finally, good management practice calls for the commander to work closely with the major command and local DOD and civilian medical treatment facilities to ensure CHAMPUS funds are managed as effectively as possible.

Maj. Ralph B. Charlip is a health affairs policy development manager in the Health Affairs and Plans Division, Directorate of Medical Plans and Resources, Office of the Surgeon General, at Bolling AFB, DC.

Professional Board Certifications

American Board of Family Practice
Col. Klaus O. Schafer, 10th Tactical Fighter Wing Clinic, Upwood AB, United Kingdom

American Board of Industrial Hygiene
Capt. Gary N. Carlton, 475th Medical Group, Yokota AB, Japan

American Board of Internal Medicine
Maj. Jeffrey K. Giguere, Wilford Hall USAF Medical Center, Lackland AFB, Texas

American Board of Otolaryngology
Maj. Charles S. Johnson, Air Force Institute of Technology, Wright-Patterson AFB, Ohio

American Board of Prosthodontics
Lt. Col. Raymond G. Koeppen, USAF Hospital, Nellis AFB, Nev.

Federal Services Board of General Dentistry
Maj. Peter S. Barringer, Griffiss AFB, N.Y.

The American Board of Obstetrics and Gynecology
Maj. Jeffrey D. Bloss, Air Force Institute of Technology, Wright-Patterson AFB, Ohio
Maj. Bruce L. Tjaden, Air Force Institute of Technology, Wright-Patterson AFB, Ohio

The American Board of Pathology
Capt. Joni L. McClain, Armed Forces Institute of Pathology, Washington, D.C.

The American Board of Pediatrics
Maj. Thomas C. Abshire, USAF Medical Center, Keesler AFB, Miss.
Capt. Michael G. Schaffrinna, Air Force Institute of Technology, Wright-Patterson AFB, Ohio

The American Board of Periodontology
Maj. Donnie E. Mayhew, USAF Medical Center, Scott AFB, Ill.

The American Board of Preventive Medicine
Capt. Richard A. Lane, USAF Hospital, Robins AFB, Ga.

The American Board of Surgery
Maj. Richard C. Neal, Air Force Institute of Technology, Wright-Patterson AFB, Ohio
Maj. David M. Remedios, 23rd Medical Group, England AFB, La.

Good thinking. *Capt. Debra A. Cavanaugh, administrator of the 26th Tactical Reconnaissance Wing Clinic, Zweibrucken, West Germany, was awarded the 1988 Jack Murphy Health Care Innovator of the Year Award. Named for Chief of the Medical Service Corps Col. John E. Murphy, this award was established in 1987 by the Air Force Surgeon General to recognize the Air Force Medical Service member who has most shown ingenuity in creating new programs that lead to a better-managed, more productive Air Force Medical Service. Captain Cavanaugh was selected for her outstanding innovative efforts in the administration of the 26th TRW Clinic. Among her many accomplishments, she improved patient access to care by creating a system of after-hours appointments for Medical Officers of the Day (MOD) that added 136 appointments per month and increased the number of same-day appointments by 11 percent. Captain Cavanaugh was cited as epitomizing "the spirit, intent and management practice" of this award.*